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Creating Checking Elemets of Hamming Codes on A New Elemental Base Based on Programmable Logical Integral Schemes

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II ELECTRONICS AND INFORMATION TECHNOLOGY

CREATING CHECKING ELEMETS OF HAMMING CODES ON A NEW ELEMENTAL BASE BASED ON PROGRAMMABLE LOGICAL INTEGRAL SCHEMES

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Abstract
The article presents a technique with a specific example of the rule for building [7, 4] Hamming code, correcting one error in the transmitted information combination. The purpose of the study is to increase the reliability of information transfer. The research methodology is based on the determination of a check digit using a programmable logic integrated circuit. As a result, the check bits are restored by information bits at characteristic points of the programmable logic integrated circuit. Recommendations are given on the practical use of check bits of the Hamming codes on the new element base based on programmable logic integrated circuits.

Keywords: *codes; integrated circuit chip; code combination; discharges; check characters.*

Introduction

In modern telecommunication systems, when transmitting messages over digital channels, it is encoded with a noise-resistant code. The idea of robust coding is to add extra characters to the message to help notice the error. Then the set of code combinations increases and consists of two subsets: allowed combinations and forbidden combinations. If, as a result of an error, the original combination has moved to a set of forbidden, then the error can be detected. However, it is possible that the set of errors will transfer the transmitted code combination to another allowed one. In this case, instead of one letter, we get another letter and the error will not be detected. In order to detect and correct errors, the allowed combination must be as different from the forbidden as possible.

Relevance of the work. In recent years, in all developed countries of the world, the transmission of information is widely used error-correcting codes. Based on this, this research option is relevant and timely.

Formulation of the problem. Using a programmable logic integrated circuit to ensure the construction of test bits.

To solve this problem, we consider the rules for constructing [7, 4] the Hamming code, correcting one error in the transmitted information combination (a1, a2, a3, a4). We write out the truth table for the three test bits. Denote the information digits by the symbol bi. Then, the test bits are restored for information on the following rule:

X_2	X_1	X_0	
0	0	0	
0	0	1	b_0
0	1	0	b_1
0	1	1	a_1
1	0	0	b_2
1	0	1	a_2
1	1	0	a_3
1	1	1	a_4

$$b_0 = a_1 \quad a_2 \quad a_4$$
$$b_1 = a_1 \quad a_3 \quad a_4$$

$$b_2 = a_2 \quad a_3 \quad a_4$$

Those. the value of b0 is formed from all ak for which x0 = 1. The value of b1 is formed from all ak for which x1 = 1, etc. A self-correcting Hamming code [7, 4] is fed to the transmitter of the communication channel, which has the form

(b0, b1, a1, b2, a2, a3, a4).

At the receiving end of the communication channel for verification symbols, a similar combination is constructed:

$B_0 = a_1 \quad a_2 \quad a_4$

$B_1 = a_1 \quad a_3 \quad a_4$

$B_2 = a_2 \quad a_3 \quad a_4$

The difference between the transmitted bits and the received check bits for bi can detect and localize the error. The location of the error is determined by the formula

$M = 2^0 (b_0 \quad B_0) + 2^1 (b_1 \quad B_1) + 2^2 (b_2 \quad B_2)$

For example, consider the Hamming construction of a code word for a message (111001111). To encode k = 9 information bits by Hamming, it is required to determine the number of check symbols from the equality 2r ≥k + r + 1.Простым подбором находим r = 4; $2^4 \geq 9+4+1$.

Those. we need the code [13, 9]. Consider the rules of construction [13, 9]. Hamming code correcting one error in the transmitted information combination

(a1, a2, a3, a4, a5, a6, a7, a8, a9). We write the truth table for the four test bits. Denote the information bits as ai, and check as bi. Then, the check digits are restored according to the following rules for information:

X_3	X_2	X_1	X_0	
0	0	0	0	
0	0	0	1	b_0
0	0	1	0	b_1
0	0	1	1	a_1
0	1	0	0	b_2
0	1	0	1	a_2
0	1	1	0	a_3
0	1	1	1	a_4
1	0	0	0	b_3
1	0	0	1	a_5
1	0	1	0	a_6
1	0	1	1	a_7
1	1	0	0	a_8
1	1	0	1	a_9

$b_0 = a_1 \quad a_2 \quad a_4 \quad a_5 \quad a_7 \quad a_9$

$b_1 = a_1 \quad a_3 \quad a_4 \quad a_6 \quad a_7$

$b_2 = a_2 \quad a_3 \quad a_4 \quad a_8 \quad a_9$

$b_3 = a_5 \quad a_6 \quad a_7 \quad a_8 \quad a_9$

Those. the value b0 is formed from all ak for which x0 = 1. The value b1 is formed from all ak for which x1 = 1, etc. Considering that for the combination (a1, a2, a3, a4, a5, a6, a7, a8, a9) = (111001111). For the verification characters, we get

$b_0 = a_1 \quad a_2 \quad a_4 \quad a_5 \quad a_7 \quad a_9 = 1 \quad 1 \quad 0 \quad 0 \quad 1 \quad 1 = 0$

$b_1 = a_1 1 \quad a_3 \quad a_4 \quad a_6 \quad a_7 = 1 \quad 1 \quad 0 \quad 1 \quad 1 = 0$

$b_2 = a_2 \quad a_3 \quad a_4 \quad a_8 \quad a_9 = 1 \quad 1 \quad 0 \quad 1 \quad 1 = 0$

$b_3 = a_5 \quad a_6 \quad a_7 \quad a_8 \quad a_9 = 0 \quad 1 \quad 1 \quad 1 \quad 1 = 0$

The code word has the form

$(b_0, b_1, a_1, b_2, a_2, a_3, a_4, b_3, a_5, a_6, a_7, a_8, a_9) = (0010110001111)$.

Considering the above, it is possible to judge that the implementation of information transmission with the help of error-correcting codes can be implemented on the basis of a new element base of a programmable logic integrated circuit. The construction of a programmable logic matrix (PLM) is based on the fact that any combinational function can be represented as a logical sum (OR operation) of logical products (AND operations). Then the scheme that implements the combinational function can be represented as follows.

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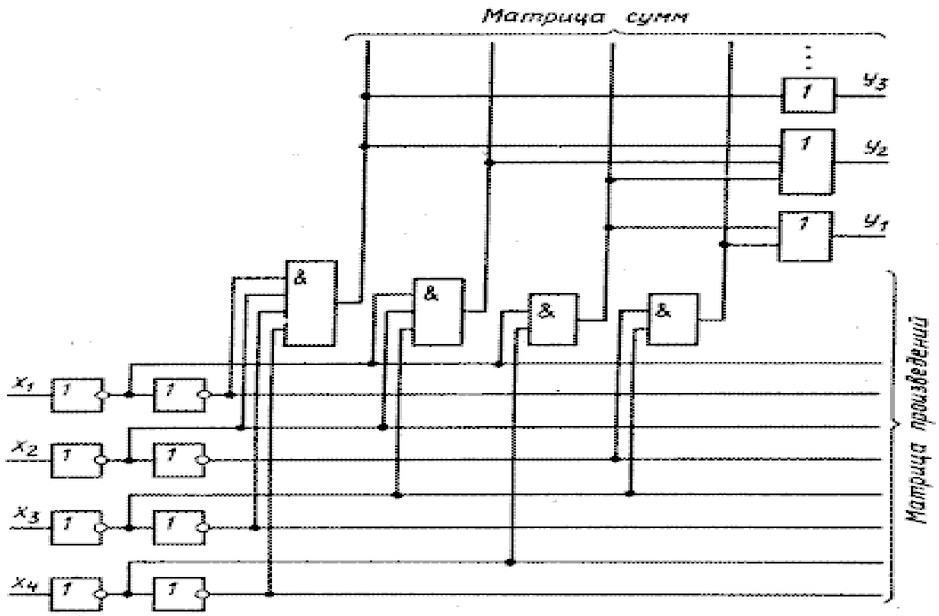

Fig.1. The principle of constructing a programmable logic matrix

At the characteristic points of a programmable logic integrated circuit, you can get check bits of Hamming codes. Based on these considerations, programmable integrated circuits can be used in encoders. The truth table at different points for the said programmable logic integrated circuit is presented in the following table 1.

The table of truth PLM

Table 1.

X_1	X_2	X_3	X_4	$А_1$	$Б_1$	$А_2$	$Б_2$	$А_3$	$Б_3$	$А_4$	$Б_4$	мп	Мс
0	0	0	0	1	0	1	0	1	0	1	0	0	1
0	0	0	1	1	0	1	0	1	0	0	1	0	1
0	0	1	0	1	0	1	0	0	1	1	0	0	1
0	0	1	1	1	0	1	0	0	1	0	1	0	1
0	1	0	0	1	0	0	1	1	0	1	0	0	1
0	1	0	1	1	0	0	1	1	0	0	1	0	1
0	1	1	0	1	0	0	1	0	1	1	0	0	1
0	1	1	1	1	0	0	1	0	1	0	1	0	1
1	0	0	0	0	1	1	0	1	0	1	0	0	1
1	0	0	1	0	1	1	0	1	0	0	1	0	1
1	0	1	0	0	1	1	0	0	1	1	0	0	1
1	0	1	1	0	1	1	0	0	1	0	1	0	1
1	1	0	0	0	1	0	1	1	0	1	0	0	1
1	1	0	1	0	1	0	1	1	0	0	1	0	1
1	1	1	0	0	1	0	1	0	1	1	0	0	1

PLA are embedded in programmable logic integrated circuits (FPGAs). The use of FPGAs in encoding devices that implements Hamming coding codes increases the reliability and reliability of information transmission in telecommunication systems.

Conclusion

As a result of the research, it is proved that the test bits are restored by information bits. This can be verified by comparing Table 1 and the table rules for constructing check bits using the Hamming method. This option is carried out on a new element base programmable logic integrated circuit.

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